

UNPUBLISHED PRELIMINARY DATA

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"Study of Heat Transfer Through Convective Layers"

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The test section to be used in the study of convection through a horizontal air layer has been completed and some initial tests have been performed. The test section consists of two aluminum plates which are held parallel to one another, the contained gap being enclosed on all four sides, with two glass windows to permit the passage of a light beam. This apparatus is placed in a Mach-Zehnder interferometer, and interferograms representing the temperature distribution in the fluid layer can be obtained.

The aluminum plates are each $1\frac{1}{4}$ " x 30" x 20" and have grooves cut in the back (in the form of a flattened double helix) for circulating water to maintain each plate at a uniform temperature. A quarter inch aluminum plate is glued and screwed over these channels to give a back surface to the plates. The aluminum surfaces enclosing

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the fluid layer have been machined so that within the central span of the plates, where data is taken, they are flat to within $\pm 0.0005''$. Towards the corners of the plates they are still flat to within $0.003''$.

The plate temperatures are controlled by two constant temperature water baths. Initial measurements with a thermocouple indicated no discernible temperature variation around either plate. During tests a seven junction copper-constantan thermopile in each plate measures the plate temperature. The bottom plate is held horizontal. The top plate is supported by the bottom plate through bakelite corner supports with provision made for adjusting the vertical spacing. There is a small reference pin protruding from each plate to be used as a reference point for analyzing the resulting interferograms. The whole test section is insulated by styrofoam plates.

The table below summarizes the tests that have been performed to date. All tests have been performed with air as the working fluid.

	<u>Turbulent Regime</u>	<u>Laminar Regime</u>	<u>Conductive Regime</u>
Rayleigh No. Range	1.09×10^5 to 23.03×10^5	1.72×10^3 to 44×10^3	1.64×10^3 to 1.67×10^3
Interplate Temp. Range	$.9^\circ\text{C}$ to 22°C	$.87^\circ\text{C}$ to 2.35°C	2.20°C to 2.24°C
Plate Spacings	10.892 cm 6.429 cm 1.976	6.429 cm 1.976 cm	1.976 cm

As can be observed from the above table, the different regimes of heat transfer in a horizontal fluid layer have been encountered. Qualitative interferograms representing the mean temperature distributions are available as well as several series of motion pictures showing the fluctuations in temperature distribution in the turbulent regime.

In the turbulent regime, asymmetry has been observed in the vertical temperature distribution. This is apparently due to heat leakage through the thin (1 mm) windows. After this has been corrected, we hope to obtain more quantitative information on the heat transfer.

In the case of fully laminar flow, a periodic horizontal temperature distribution is observed and it is necessary to measure the vertical temperature distribution at a number of horizontal locations to get the mean vertical temperature. Preliminary measurements have also been made on the initial transition to laminar flow.

Experiments are continuing in order to obtain good quantitative data on the vertical temperature distribution, particularly in the case of a fully turbulent flow. Two thick (2") windows have been ordered, and the installation of these should reduce end effects. A laser light source is available for use when the thick windows are installed.

An apparatus for containing a horizontal liquid layer has also been designed and will be constructed. The use of a liquid will permit larger Rayleigh numbers with relatively small end errors.